

Science of Design Working Group Outbrief

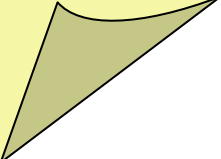
Ship Design Process Workshop

April 2, 2009

Outline

- Define Design
 - What is design?
 - What is NOT design?
- What parts of design are:
 - Art?
 - Science?
- For the Science part
 - What is well known?
 - What needs to be

Design (as a verb)

- Time
 - It exists in a time domain (it cannot be represented as a diamond in a GANTT chart)
 - Knowledge
 - It requires
 - Cognition
 - Structured
 - Prediction
 - Creation
 - Estimation
 - Decision Making
 - Modeling
 - Synthesis
 - Fancy word for “putting things together”
 - Not well defined solutions
 - Compromise
 - Requires a balance of requirements
 - Aesthetics
 - Integrative
 - Decompositive/Decomposition
 - Assessment
 - Artifact (An image, in the generic sense)
 - Activity (It is an)
 - Arrange of elements
 - Meet Requirements
 - Art
 - Human
 - Intuition
 - “Not Noiseless”
 - Pattern Making
 - Cost
 - In the generic sense, cost vs. benefits
 - Recursive
 - Fractal/Holographic
 - Nested Teams
 - Social
 - Organization
- 

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Not Sure

- Requirements Definition
 - It can be both (Venn diagram intersection)
 - Requirements need to be aware of design risks and costs
- Innovative
- Iterative
- Engineering
- Optimization
- Hierarchy
- Producibility
- Ambiguity/Uncertainty
- Architecting
- Analysis

Not Design

- Production of the Object of Design
- Deterministic
- Invention
- Research

Process View

Requirements
Development

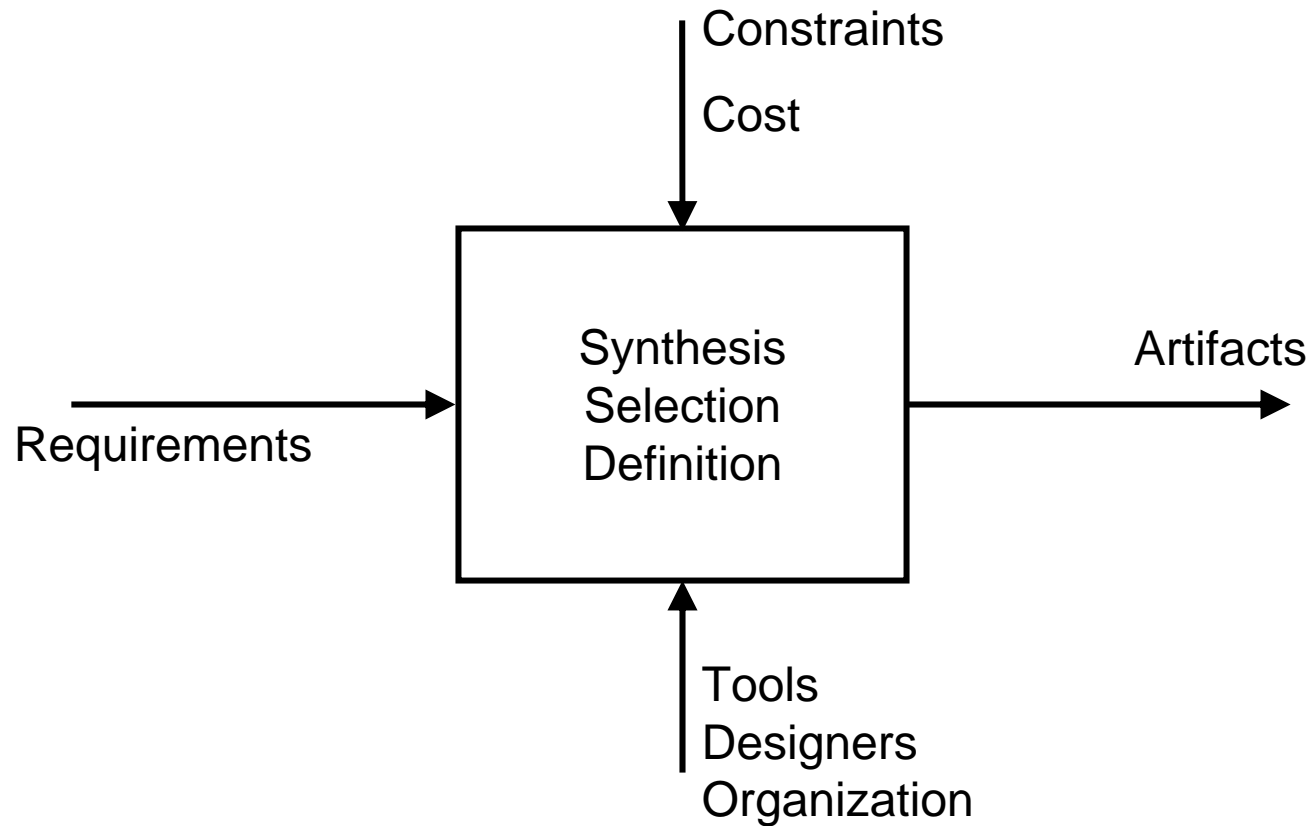
Requirements
Analysis

Architecture
(Philosophy)

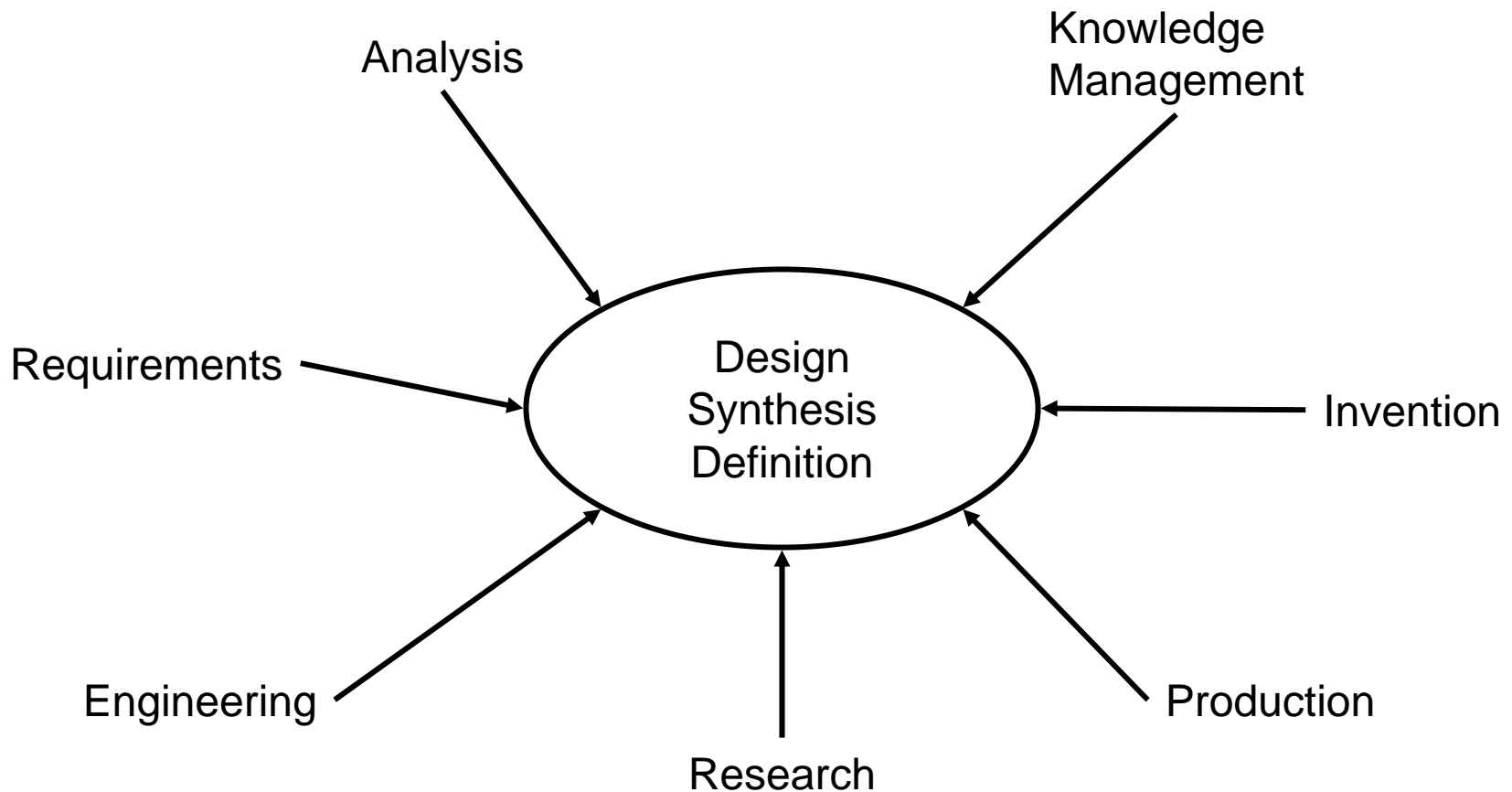
Synthesis

Analysis

IDEF0 View



Affinity Diagram



Art

- Intuition
- Creation (1)
- Aesthetics (1)

Science

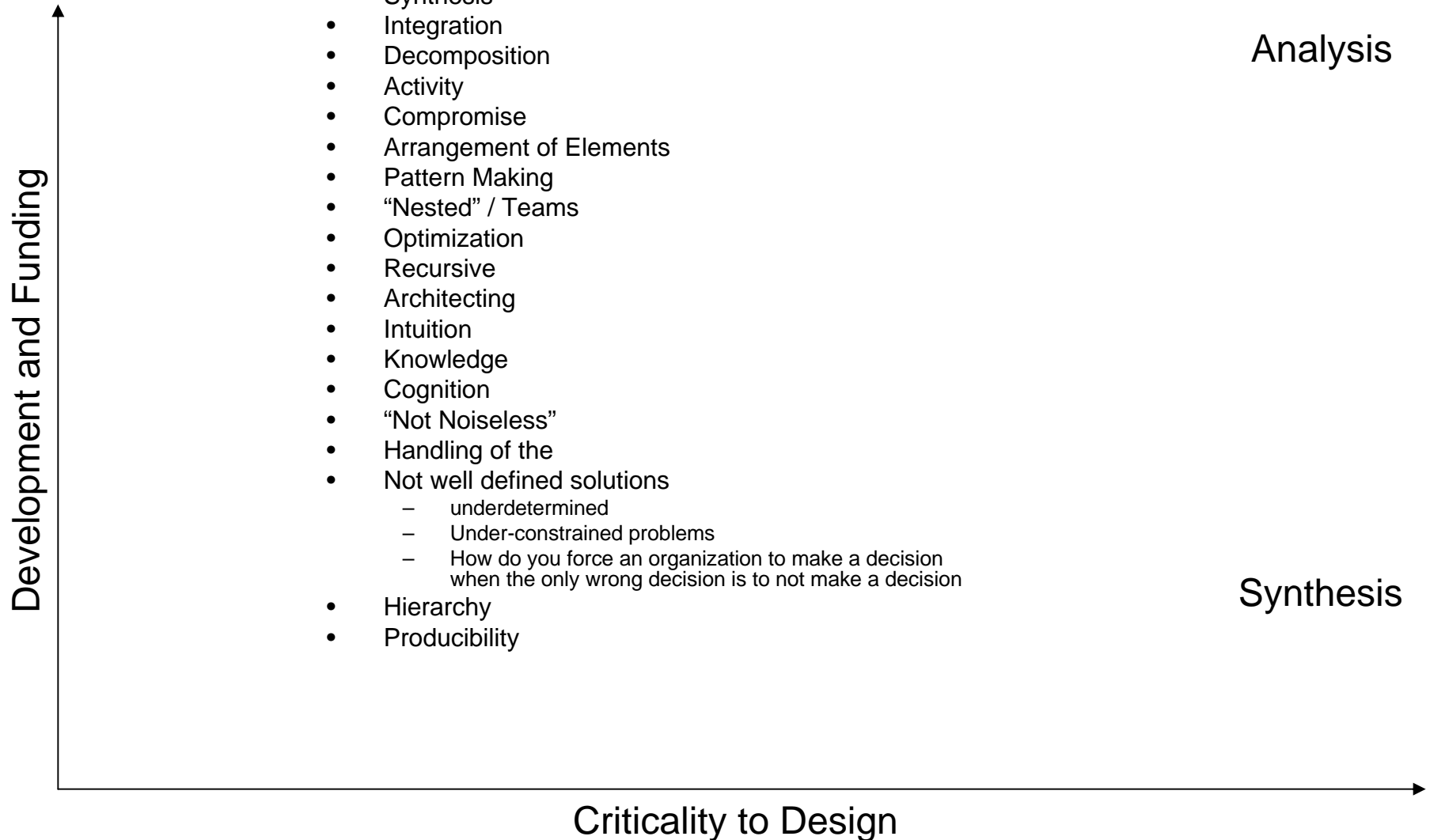
- Structured
 - Prediction (3)
 - Modeling (1)
 - Assessment
 - Artifact (1)
 - Meet Requirements (1)
 - Balance
 - As in balancing a design to match disciplines
- Ambiguity / Uncertainty
 - Analysis (2)

Art → Science

- Estimation
- Decision Making
- Synthesis (3)
- Integration (4)
- Decomposition (1)
- Activity
- Compromise
- Arrangement of Elements (2)
- Pattern Creation (5)
- “Nested” / Teams
- Optimization (3)
- Recursive (1)
- Architecting (2)
- Intuition
- Knowledge (4)
- Cognition
- “Not Noiseless”
 - Handling of the
- Not well defined solutions
 - underdetermined
 - Under-constrained problems
 - How do you force an organization to make a decision when the only wrong decision is to not make a decision
- Hierarchy
- Producibility (5)

- **Pattern Creation**
 - How to go about imposing order on the design artifacts including establishing the boundaries of systems.
- **Producibility**
 - Any concept or action that reduces the ship acquisition cost without degrading the ship's performance. E.g., estimate how long it would take to design the
 - A repeatable, verifiable structured approach to design for production.
- **Integrative**
 - including the human element in putting everything together.
- **Knowledge**
 - Knowledge management leading to insight and understanding as a critical enabler of design. Knowledge management includes: capture, retention, access, communication, application...
- **Synthesis**
 - The ability to achieve balance quickly and efficiently through the design iteration
- **Prediction**
 - Minimization of uncertainty and error in the synthesis, effectively increasing the rate of convergence of design
- **Optimization**
 - To have the ability to explore the tradespace to better find the solution(s) in nonlinear spaces
 - To decide between dissimilar but equally good solutions
 - The ability to find/identify the non-dominated solutions for a given set of objectives at the appropriate level within the system hierarchy

Chris' Slide



Backup Slides

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- Science involves following the scientific method, which in this case it is meant
 - that we can produce repeatable and verifiable results
- Demand for “scientific” design is increasing and the tools that supply this capability are becoming more Science helps you find a better/faster/cheaper solution when your requirements become more orthogonal and the problem is more constrained
- Today’s computing power coupled with M&S techniques enable us to keep up with the increased demand for following a scientific approach to design

- Design includes requirements?
 - At some levels it does, if design is like an onion, in one layer, design can include requirements development and analysis
- Art and science may be inseparable
 - Think of heuristics used in art, that once the artists learn them, they can do the art better
 - Rules of thirds, golden ratio, perspective, music, etc... these are backed by reasons